sustainability

MDPI

Article

Analysis of the Evolution of Foreign Trade Patterns and Influencing Factors in Henan Province from 2002 to 2021

Yalin Wang, Jianzhong Liu, Yinbao Zhang, Yabo Wang, Shiyu Zhou, Jingwei Zhang and Xinjia Zhang *

School of Geoscience and Technology, Zhengzhou University, Zhengzhou 450001, China; wangyalin@gs.zzu.edu.cn (Y.W.); liujianzhong@zzu.edu.cn (J.L.); zhangyinbao@zzu.edu.cn (Y.Z.); wangyb1108@gs.zzu.edu.cn (Y.W.); edmundzhou@gs.zzu.edu.cn (S.Z.); zjw111@gs.zzu.edu.cn (J.Z.)
* Correspondence: zhangxinjia@zzu.edu.cn; Tel.: +86-178-0383-9862

Abstract: Foreign trade is an important part of the national economy. Promoting the development of foreign trade can regulate the optimal allocation of resources, raise the level of domestic productivity, and accelerate economic development. As a traditional inland agricultural province, Henan Province has inherent disadvantages in developing foreign trade due to its geographical location. However, it has characteristic advantages in terms of population and transportation, so it is necessary to study the pattern of foreign trade and the factors affecting it in this region. In this research study, statistical data were assessed with methods such as the foreign trade dependence, geographical detector, and gravity models to analyze the trade scale, pattern, spatio-temporal variation characteristics, and foreign trade mechanisms in Henan Province. The results show that the trade pattern of Henan Province from 2002 to 2021 has evident spatial and temporal heterogeneity, with a relatively homogeneous overall commodity structure, weak competitive advantages, and a high degree of dependence on US trade. Innovation and transportation are essential internal factors, while the external factors are positively affected by the GDP of both Henan Province and the trading countries, FTAs, trade openness, and the population in the long run and are negatively impacted by distance. This study provides suggestions and decision support for formulating foreign trade policies for Henan Province. It also provides a research basis for related corresponding studies of other regions with similar characteristics.

Keywords: regional development; foreign trade; influencing factors; geographical detector; gravity model; Henan

Citation: Wang, Y.; Liu, J.; Zhang, Y.; Wang, Y.; Zhou, S.; Zhang, J.; Zhang, X. Analysis of the Evolution of Foreign Trade Patterns and Influencing Factors in Henan Province from 2002 to 2021. *Sustainability* **2023**, *15*, 15341. https://doi.org/10.3390/su152115341

Academic Editors: Vytautas Snieška, Vaida Pilinkiene and Daiva Dumciuviene

Received: 29 August 2023
Revised: 18 October 2023
Accepted: 24 October 2023
Published: 26 October 2023

1. Introduction

Foreign trade is an indispensable and essential part of the national economy, which can not only directly promote economic growth but also indirectly impact the economy through consumption, government expenditure, investment, and other ways [1]. To address the regional foreign trade problem, much work has already been conducted by scholars around the world, including in France [2], Brazil [3], the Czech Republic [4], and other regions [5–7].

Foreign trade is also a vital driving force for China's economic development [8], especially the Belt and Road policy, which promotes China's economic growth, promotes the economic development of the countries along the route [9], and contributes to the sustainable development of the local economy [10,11]. China formally acceded to the WTO on 11 December 2001, and has gradually formed a pattern of opening up to the outside world: "special economic zones-open coastal cities-open coastal economic regions-the mainland." Within in-depth studies of China's foreign trade issues, more and more scholars have begun to pay attention to regional (provincial administrative regions) foreign trade issues. Exploring regional (provincial administrative regions) foreign trade issues is not only related to an increase in the scale and level of regional import and export trade but will also profoundly affect the transformation and upgrading of local development. Improving the international influence of regions and increasing their opportunities for opening up and cooperation can promote the sustainable development of regional economies [12–15]. Existing studies have

mainly focused on coastal areas [16–23] and border provinces [24–29], with less attention paid to central inland areas [30–32]. For example, Song et al. used the RCA index, inter-regional input–output model, and other methods to analyze the evolution of Hainan's foreign trade pattern and its economic linkages with domestic provinces, autonomous regions, and municipalities [17]; Liu et al. used the concentration index, positional change index, and HM index to analyze changes in the trade pattern and characteristics of the three northeastern provinces in relation to countries along the "Belt and Road" route [27]; Gao et al. used the comprehensive trade share index and HM index to analyze the degree and symmetry of trade dependence between Jiangxi and countries along the "Belt and Road" [30].

Henan Province, a representative of the central region, has long needed to catch up with foreign trade. In 2021, the import and export volume of Guangdong Province, China, amounted to USD 1298 billion, while that of Henan Province only amounted to USD 127 billion, significantly lagging behind in the degree of opening up to the outside world. Henan ranks 10th in the country regarding import and export trade (Table 1), with the vast majority of the top nine being coastal provinces such as Guangdong, Jiangsu, and Zhejiang. An important factor contributing to this situation is that Henan (Figure 1), a traditional inland agricultural province, has an inherent disadvantage in foreign trade development due to its geographical location. However, as the third largest province in China in terms of population, an essential national comprehensive transportation hub, and a critical grain conversion and processing province, Henan's economy and foreign trade have been developing continuously for a long time. Therefore, it is necessary to study the pattern of foreign trade and the factors influencing it in this region, which lacks the basic conditions for foreign trade but has characteristic advantages.

Table 1. Economic structure of Henan Province.

Indicator	Data	Rank of Henan in the Country
Average wage (CNY)	76,261	31
Investment in fixed assets (%)	4.500	23
GDP (CNY 100 million)	58,887	5
Primary industry (CNY 100 million)	5621	3
Secondary industry (CNY 100 million)	24,332	5
Tertiary industry (CNY 100 million)	28,935	7
Per capita annual disposable income (CNY)	26,811	24
Per capita consumption expenditures (CNY)	18,391	26
Grain (10,000 tons)	6544.200	2
Oil-bearing crops (10,000 tons)	657.280	1
Cotton (10,000 tons)	1.400	9
Meat (10,000 tons)	646.810	3
Number of university students (10,000 persons)	269	1
Total resident population (10,000 persons)	9883	3

Most studies on foreign trade in Henan Province are qualitative [33–37], with fewer quantitative analysis studies [38–41]. For example, Ren et al. qualitatively proposed to deal with the challenges brought by the "Belt and Road" to Henan Province in terms of transportation, logistics, and cross-border trade [33]; Yi found that the problems faced by the high-quality development of Henan's foreign trade in terms of sustainability are mainly the lack of structural efficiency and foreign trade professionals [36]; Feng et al. utilized trade integration, competition, and complementarity of foreign trade in Henan Province to study the development of Henan's foreign trade [40]; Cui et al. used principal component analysis to analyze a constructed index system for the evaluation of open-door competitiveness [41]. Therefore, adopting a suitable and reliable methodology for this study is essential. The geographical detector model is a powerful tool for driver and factor analysis [42–47], and trade gravity models are mainly used to analyze specific commodities' evolution and influencing factors [48–51].

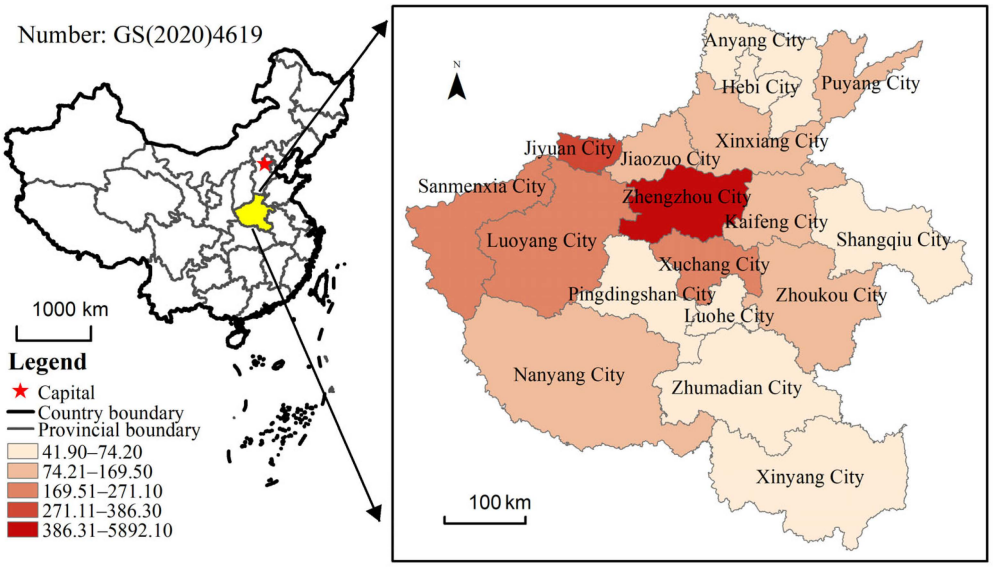

Figure 1. Position of Henan Province in China and total import and export trade by cities in Henan Province in 2021.

Therefore, this study analyzes the trade scale, pattern, and characteristics of spatial and temporal changes in Henan Province by using various statistical data and combining foreign trade dependence, RCA (revealed comparative advantage index), HM (hubness measurement index), and TII (trade intensity index). Subsequently, the geographical detector and gravity models are used to conduct a more in-depth study of the factors and mechanisms influencing the trade pattern of Henan Province from both internal and external perspectives. This study will provide decision support for further opening up and optimizing trade relations in Henan Province, as well as providing a research basis for other corresponding regions with similar characteristics.

2. Methodology and Data

The geographical detector model is used to explore the internal factors affecting the foreign trade pattern of each city in Henan Province in terms of economics, industrial structure, innovation ability, and transportation conditions. The trade gravity model is used to analyze the external factors affecting foreign trade in Henan Province in terms of distance, economics, openness, population, and export structure.

2.1. Methodology

2.1.1. Foreign Trade Dependence

Foreign trade dependence is an indicator of the degree of dependence of a country or region on foreign markets [52]. The greater the degree of foreign trade dependence, the closer the region's economic development is to the international market. The formula for calculating foreign trade dependence is:

$$F = \frac{I_i + E_i}{G} \times 100\% \quad (1)$$

where F represents Henan's foreign trade dependence; I_i represents Henan's total import trade; E_i represents Henan's total export trade; G represents Henan's GDP.

2.1.2. RCA

The RCA index indirectly reflects the trade structure of a region by calculating the export of goods, which can reflect the main advantages of the region's goods to a greater extent [53]. It is used in the study to calculate the outstanding products of Henan's exports. The formula for the RCA index is:

$$RCA_{ij} = \frac{\frac{X_{ij}}{X_i}}{\frac{X_j}{X}} \tag{2}$$

where X_{ij} denotes the export value of product j from Henan Province; X_i means the total export value of all commodities from Henan; X_j is the Chinese export value of product j; and X is the total export value of all commodities in China. $RCA_{ij} > 1$, indicating that the export of j products in Henan is relatively concentrated and has a strong comparative advantage in the domestic market.

2.1.3. HM

HM is an important indicator used to measure the degree of trade interdependence and to analyze the degree of market dependence of a region's exports on its trading partners [54].

$$HM = \frac{E_{ij}}{E_i} \times \left(1 - \frac{I_{ij}}{I_j}\right) \tag{3}$$

where E_{ij} denotes the export amount from Henan province to country j; E_i denotes the total export amount of Henan province; I_{ij} denotes the import amount of Henan province from country j; I_j denotes the total imports of country j. HM means the degree of dependence of Henan province's goods exports on the trade market of country j. The value of HM lies in the interval (0, 1). The closer the value of HM is to 1, the more dependent Henan province's exports are on the trade market of country j [55].

2.1.4. Trade Intensity Index

The trade intensity index is used to measure the closeness of trade linkages between countries or regions and was proposed by the economist Brown [56].

$$TII = \frac{\frac{E_{ij}}{E_i}}{\frac{I_j}{I_w}} \tag{4}$$

where TII denotes the trade intensity index of Henan Province to country j; E_{ij} denotes exports from Henan Province to country j; E_i denotes the total exports of Henan Province; I_j denotes the total imports of all goods in country j; I_w denotes the total imports of all goods in the world. The larger the trade intensity index between two regions, the more closely they trade with each other.

2.1.5. Geographical Detector

The geographical detector method is used to analyze the spatial divergence patterns of geographic phenomena and detect their influencing factors [57]. In the geographical detector method, factor detection can express the extent to which factor X explains the spatial heterogeneity of attribute Y.

$$q = 1 - \frac{\sum_{k=1}^{M} N_h \sigma_h^2}{N\sigma^2} \tag{5}$$

In the given equation, $k = 1, \ldots, M$ represents the classification of variable Y or factor X; N_h and N represent the number of cells in layer k and in the entire area, respectively; σ_h^2 and σ^2 denote the variances of Y values in layer k and in the whole area, respectively. Variable q takes values in the range [0, 1], with larger values of q indicating more pronounced spatial heterogeneity in Y. When stratification of Y is due to independent variable X, it can be assumed that the larger the value of q, the stronger the ability of independent variable X to explain attribute Y, and vice versa.

In practical situations, where a single factor does not determine the distribution of attributes, interaction detection by the geographical detector can help us to detect interactions between different risk factors. The driving factors may be independent of

each other or may act together, and the results of interactions between factors fall into four categories (Table 2). It is expected that the *q*-value of the geographical detector and interaction detection be used to indicate the extent to which the proposed influencing factor explains the foreign trade of Henan Province.

Table 2. Types of interaction between two factors.

Decision Rules	Types of Interaction
$q(X_1 \cap X_2) < \text{Min}(q(X_1), q(X_2))$	Nonlinear attenuation
$\text{Min}(q(X_1), q(X_2)) < q(X_1 \cap X_2) < \text{Max}(q(X_1), q(X_2))$	Single-factor nonlinear attenuation
$q(X_1 \cap X_2) > \text{Max}(q(X_1), q(X_2))$	Two-factor enhancement
$q(X_1 \cap X_2) = q(X_1) + q(X_2)$	Independent
$q(X_1 \cap X_2) > q(X_1) + q(X_2)$	Nonlinear enhancement

Combined with the evaluation indicators proposed by previous scholars, the internal influencing factor indicators of foreign trade in Henan Province were created [28,42–47,58,59]. The interpretation of the geographical detector indicators is shown in Table 3:

Table 3. Geographical detector indicators.

Category	Indicator	Indicator Interpretation
Economy	GDP (x_1)	Per capita GDP
	Consumption (x_2)	Per capita consumption expenditures of urban households by city
	Urbanization (x_3)	Urbanization rate of cities
Industry Structure	Secondary (x_4)	Secondary industry as a percentage of GDP
	Tertiary (x_5)	The tertiary industry as a percentage of GDP
	Investment (x_6)	Utilized foreign capital
Transport	Highways (x_7)	Product of the quantity of goods transported by road and the distance traveled
	Railroads (x_8)	Railway density
Innovation	Patent (x_9)	Total patent applications
	R&D (x_{10})	Intramural expenditures on R&D
	Education (x_{11})	Education spending as a percentage of public spending
	Students (x_{12})	Number of university students

Data discretization was performed using the ArcGIS natural breakpoint method.

2.1.6. Trade Gravity Model

Applying the gravity model to the geoeconomic field, it can be considered that the trade volume of two countries is directly proportional to the size of their respective economies and inversely proportional to geographical distance.

$$T_{ij} = G\frac{M_i M_j}{D_{ij}} \tag{6}$$

where T_{ij} denotes the trade volume between the two countries; M_i and M_j are the total import and export trade between economies i and j; and D_{ij} represents the distance between the two economies.

Linnemann adds population and preferential trade agreements to the endogenous variables, after which other trade cost factors other than physical distance can be added to the traditional gravity model to optimize model estimation, taking the natural logarithm on both sides of the equation, resulting in a new gravity model approach [60]:

$$LnT_{ij} = a_0 + a_1 lnM_i + a_2 lnM_j + a_3 lnD_{ij} + a_4 X_{ij} + \epsilon_{ij} \tag{7}$$

where a_0 is the constant term; a_1~a_4 are the regression coefficients of each variable; M_i and M_j represent the gross products of economies i and j, respectively; D_{ij} represents the distance between the two economies; X_{ij} represents other possible variables affecting the two trades; ϵ_{ij} is the random interference term.

In the age of globalization, trade is constantly changing dynamically, influenced by many factors and complex mechanisms. A significant proportion of these factors cannot be quantified. These factors also have different coverage times and may not be reflected in the changes in regional trade patterns immediately. So, this study selected the long-lasting quantifiable factors that may have played a role in the whole study period, such as economic freedom, FTAs, population size, and other 12 variables [8,12,15,26,28], and explored the specific mechanism of their role through the gravity model.

$$LnY_{ij} = a_0 + a_1 lnDIST_j + a_2 lnHGDP_{it} + a_3 lnGDP_{jt} + a_4 lnRATE_{jt} + a_5 lnTO_{jt} + a_6 lnEFW_{jt} + a_7 FTA_{jt} + a_8 lnHPEO_{it} + a_9 lnPEO_{jt} + a_{10} lnFUEL_{jt} + a_{11} lnICT_{jt} + a_{12} lnMMTL_{jt} + \epsilon_{ij} \quad (8)$$

where Y_{ij} is the total import and export or export value of Henan Province and its trading countries; a_0 is the constant term; a_1~a_{12} are the regression coefficients of each variable; ϵ_{ij} is the random disturbance term. Explanatory notes for the remaining variables are shown in Table 4.

Table 4. Variable data description of the trade gravity model.

Category	Variable	Description
Distance	$DIST_j$	Spatial distance from Zhengzhou to capital
Economy	$HGDP_{it}$	GDP of Henan Province
	GDP_{jt}	GDP of trading countries
	$RATE_{jt}$	Exchange rate of the local currency vis-à-vis USD
Openness	TO_{jt}	The degree of openness of the trading country's market to the outside world, i.e., the share of total exports and imports in GDP
	EFW_{jt}	12 types of indicators to take the average value
	FTA_{jt}	Dummy variable for bilateral trade agreements; 1 for the period from the year of entry into force and subsequent years, 0 for the rest
Population	$HPEO_{it}$	Total resident population in Henan Province
	PEO_{jt}	Total population by trading country
Export structures	$FUEL_{jt}$	Fuel exports as a percentage of merchandise exports
	ICT_{jt}	ICT product exports as a percentage of total product exports
	$MMTL_{jt}$	Ore and metal exports as a percentage of merchandise exports

2.2. Data

Since China formally joined the WTO on 11 December 2001, the study period for all data in this paper began in 2002. The data sources and related information used in the study are shown in Table 5.

Table 5. Data source.

Data	Data Source
Trade data	DRCNET's Foreign Trade Database "https://data.drcnet.com.cn/ (accessed on 14 May 2023)"
FTA	China FTA Service Network "fta.mofcom.gov.cn (accessed on 17 May 2023)"
DIST	Measured through ArcGIS 10.8 software
EFW	Heritage Foundation "www.heritageofthomasville.com (accessed on 17 May 2023)"
GDP; RATE; TO; PEO; FUEL; ICT; MMTL	World Bank database "data.worldbank.org (accessed on 18 May 2023)"
HGDP, HPEO, and other prefecture-level city data	Official website of the Henan Provincial Bureau of Statistics "https://tjj.henan.gov.cn/ (accessed on 20 May 2023)"

3. Results and Analysis

3.1. Analysis of Foreign Trade Pattern of Henan Province

3.1.1. The Overall Pattern of Henan's Foreign Trade

According to Figure 2, the total import and export of Henan Province is growing gradually, and export is developing rapidly. The development of foreign trade in Henan Province can be roughly divided into four stages: (1) the starting period (2002–2010, S1)—China's accession to the WTO in 2001; after the rapid growth of foreign trade, Henan's foreign trade development due to its inland location is subject to limitations, in general, with a slow growth rate far worse than the overall trend in China; (2) the rapid development period (2011–2015, S2)—with the recovery of the global economy and the implementation of the "Belt and Road" policy, the trend of Henan's foreign trade is basically in line with China's general trend; foreign trade has grown significantly and rapidly, with the total import and export amounts increasing from USD 35.585 billion in 2011 to USD 77.148 billion in 2015; (3) the period of stable growth (2016–2018, S3)—the global economic growth rate is slowing down, and China's import and export trade begins to experience negative growth, but Henan Province is not significantly affected and still shows a stable and improving trend; (4) the period of restored growth (2019–2021, S4)—affected by the global economic situation and COVID-19, China's import and export trade declines slightly; Henan Province is also affected in this period, but it slowly recovers to reach USD 127.009 billion in 2021.

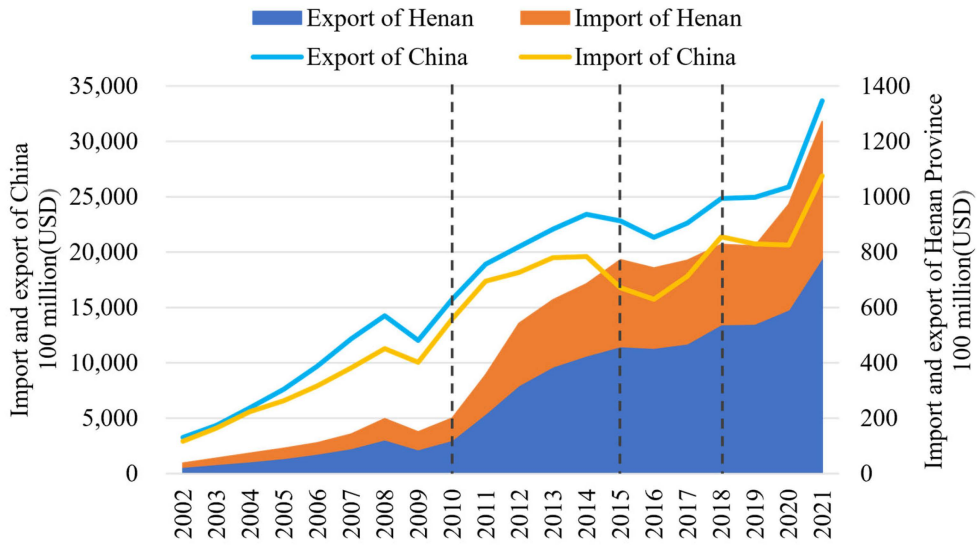

Figure 2. Import and export volume in Henan Province and China from 2002 to 2021.

A greater value of foreign trade dependence indicates that a region's economic development depends more on its connection with the international market and on a stronger sense of participation in the international division of labor and competition. Data on foreign trade dependence (Figure 3) show that Henan's foreign trade dependence is low, with a slow growth trend; the financial crisis of 2008 and COVID-19 have a relatively small impact on Henan's foreign trade dependence, suggesting that Henan's trade potential with the international market is good and that it has a certain level of risk resistance. China has a closer relationship with the global market, while Henan's foreign trade dependence is lower than China's. However, since 2012, Henan's foreign trade dependence has experienced the opposite trend from China's overall foreign trade dependence.

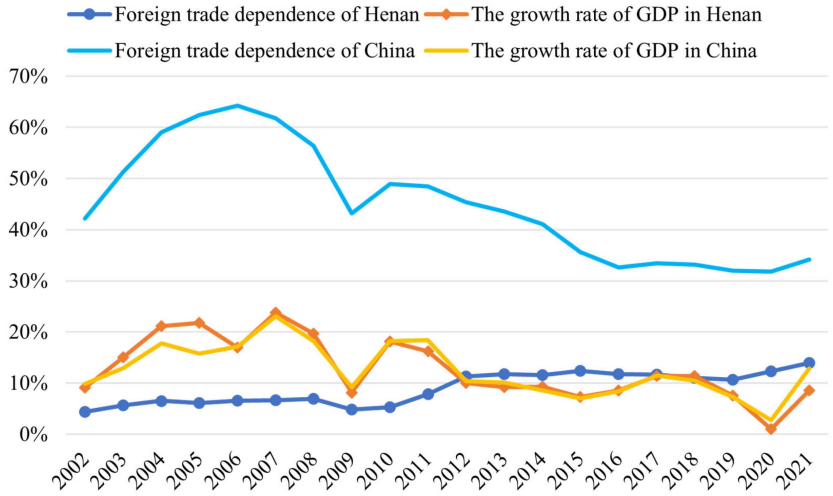

Figure 3. Foreign trade dependence in Henan Province and China from 2002 to 2021.

3.1.2. Analysis of the Commodity Structure of Henan's Foreign Trade

According to Figure 4, the commodity structure of imports from Henan Province changed drastically over the study period, while the overall commodity structure of China changed relatively little.

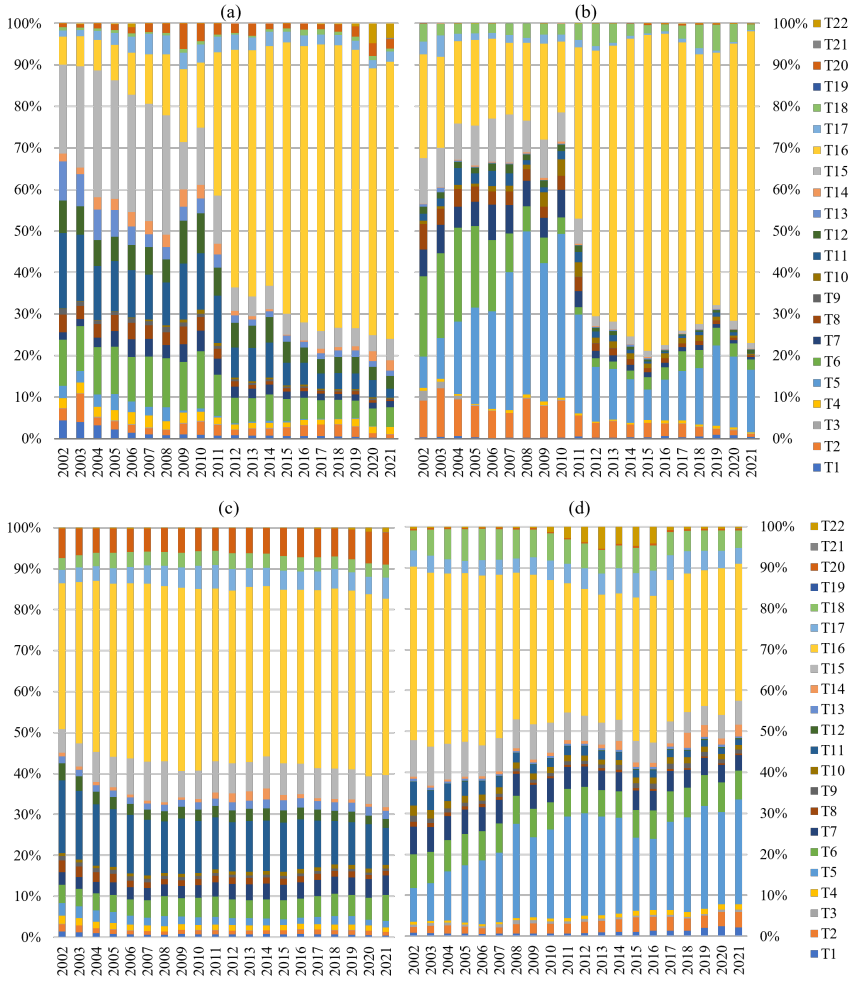

Figure 4. Structure of import and export commodities in Henan Province and China from 2002 to 2021. (**a**) Export commodity structure of Henan; (**b**) import commodity structure of Henan; (**c**) export commodity structure of China; (**d**) import commodity structure of China.

In 2002, the commodity structure of Henan Province's exports was dominated by base metals and their products (T15, 21.45%), textile raw materials and textile products (T11, 18.15%), chemical products (T6, 11.15%), and stone products, ceramic products, and glass products (T13, 9.42%). Since then, the top-ranked share of T15, although rising until 2008, continued to decline to a meager share; T11, T6, and other high-share commodities also fell sharply. By 2021, only machinery, electrical equipment, audio equipment, and their parts (T16) accounted for as much as 66.75% of total exports, followed by chemical products (T6, 4.72%) and special deals (T22, 3.47%). This result shows that the export structure of Henan Province changed from labor-intensive products to high-tech products, and the structure was obviously optimized. Over the same period, the overall structure of China's export commodities was highly stable, with T16 accounting for a very high proportion of commodities.

The imports of Henan Province from 2002 to 2021 were mainly dominated by machinery, electrical equipment, audio equipment and parts (T16), and minerals (T5). T16 did not undergo any significant changes in its share from 2002 to 2010 and then rose rapidly to 41.25% in 2011. T5 also experienced more obvious fluctuations, with its share falling after rising to a peak of 39.56% in 2010 and recovering slightly since 2017. During the same period, the overall structure of China's export commodities was relatively stable, with T16 accounting for the highest percentage in the long term, while T5 showed a significant upward trend. A detailed product classification and description are shown in the Table A1 (Appendix A).

Overall, Henan Province's foreign trade commodity pattern is relatively homogeneous, dominated by the import and export of machinery, electrical equipment, audio equipment, and their parts, and its export advantage of animal and plant products is weak. This pattern shows that Henan Province may have obvious trade risks and has yet to fully exploit its advantages as a central grain province.

3.1.3. Competitive Analysis of Henan's Foreign Trade

Due to the special nature of weapons, ammunition, and their parts (T19) and of artworks (T21), as well as the meaninglessness of unclassified goods (T22), they will not be analyzed.

The RCA index (Figure 5) indicates the competitive advantage of commodities. Henan's animal and vegetable oils and waxes (T3) showed a strong export advantage from 2004 to 2019. Precious jewelry and coins (T14) also established a strong competitiveness in the early stage, faltering slightly in 2012–2016 before recovering to the level from the earlier part of the study period after 2017. Movable and animal products (T1), chemical products (T6), and base metals and their products (T15) had a strong lead in the early part of the period and then their share decreased all the way through. Plant products (T2) maintain a more stable advantage. Machinery, electrical equipment, audio equipment, and their parts (T16) began to have a specific advantage since 2012, indicating that high-tech products in Henan Province saw a remarkable development. Nevertheless, the RCA index of vehicles, aircraft, ships, and related transportation equipment (T17), medical equipment (T18), and other high-precision products never exceeds 1, indicating that Henan's science and technology level still has more room for improvement.

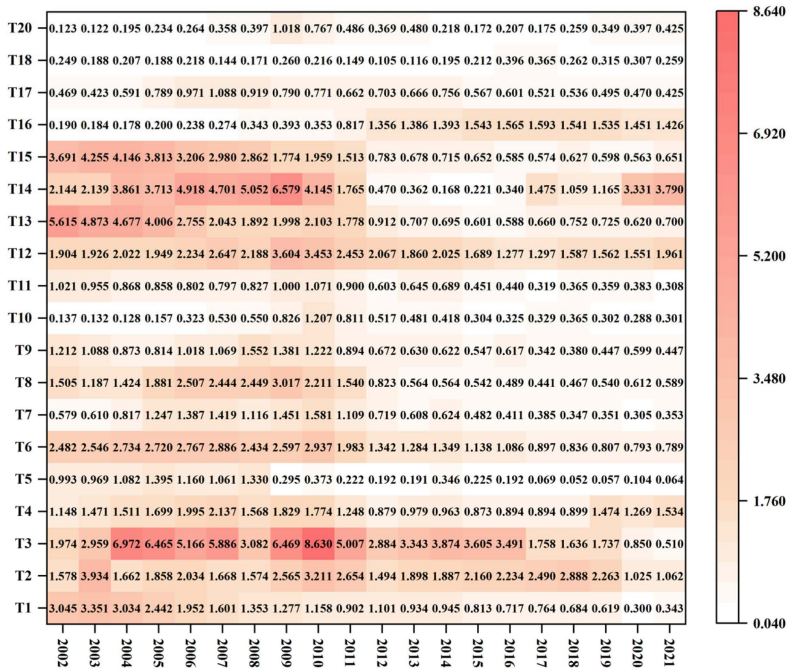

Figure 5. RCA by commodity in Henan Province from 2002 to 2021.

3.1.4. Analysis of Henan's Foreign Trade Dependence

Table 6 shows that Henan Province has been trading closely with the United States, the Netherlands, Japan, the United Kingdom, South Korea, and Germany for a long time. It is worth mentioning that Henan's dependence on the US is the highest and increases year by year, and the latest data show that this dependence reaches 33.39%, much larger than that of other countries and regions. Against the backdrop of the trade war between China and the United States, this dependence may adversely affect the sustainable development of Henan's foreign trade.

Table 6. Top 8 countries in Henan Province's foreign trade HM index from 2002 to 2021.

2002–2010		2011–2015		2016–2018		2019–2021	
US	14.03%	US	27.71%	US	31.89%	US	33.39%
Republic of Korea	10.95%	Netherlands	7.52%	Japan	8.41%	Netherlands	6.50%
Japan	7.53%	Japan	6.67%	Netherlands	7.57%	Japan	4.69%
India	3.31%	Republic of Korea	3.11%	UK	2.96%	UK	3.92%
Germany	2.89%	UK	2.97%	Germany	2.58%	Republic of Korea	3.11%
Netherlands	2.35%	India	2.34%	Republic of Korea	2.55%	Germany	2.91%
Russia	2.00%	Germany	2.30%	India	2.33%	Canada	2.18%
Vietnam	1.95%	Canada	2.05%	Vietnam	2.22%	Australia	2.15%

As can be seen in the regional distribution (Figure 6), the African region and Henan Province had close trade relations. For example, African countries such as Benin, Gambia, Guinea, Djibouti, Liberia, and Nigeria had profound trade exchanges with Henan for many years. Brunei, Myanmar, North Korea, Vietnam, Laos, and other Southeast Asian countries also had a high trade intensity index with Henan Province. After the implementation of the "Belt and Road" strategy, the export trade cooperation between Henan Province and Luxembourg, the Netherlands, Venezuela, Yemen, Saudi Arabia, Uzbekistan, Kyrgyzstan, and other countries also increased significantly. Still, the trade intensity index of Henan Province with European countries such as Switzerland, Austria, France, Denmark, and Finland was at a low level for many years.

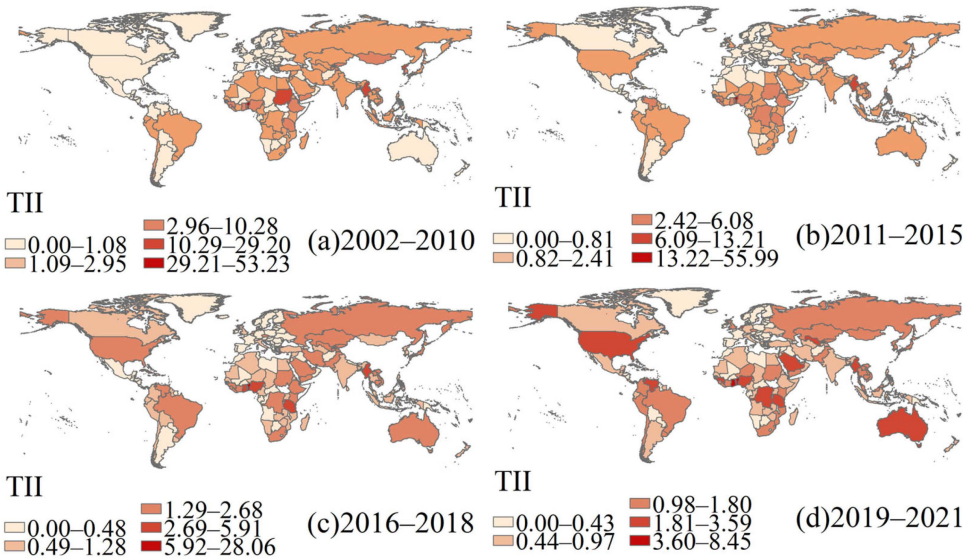

Figure 6. Trade intensity index of Henan Province's foreign trade from 2002 to 2021.

3.2. Detection of Internal Influencing Factors of Foreign Trade in Henan Province

In the study of the foreign trade scale of prefecture-level cities in Henan Province during the period S1–S4, the results (Figure 7) show that there is apparent spatial heterogeneity in its distribution: the foreign trade scale of Zhengzhou, the capital of the province, is much larger than that of the other cities, and the foreign trade scale of the cities in the west is generally larger than that in the east.

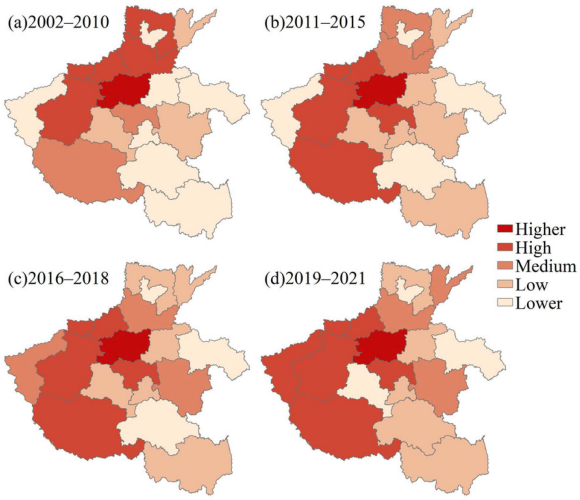

Figure 7. Scale of foreign import and export by city in Henan Province from 2002 to 2021.

Based on this, the import and export volume between Henan Province and each trading country is the dependent variable, and the 12 independent variables (Table 3) are divided into four categories: the economy, industrial structure, transportation, and innovation. The geographical detector method was used to study the internal influencing factors of Henan Province's foreign trade from 2002 to 2021.

3.2.1. Single-Factor Detection

The results (Figure 8) show that the different factors passed the significance test at all stages but with different levels of expressiveness: the top three dominant factors in S1 were, in order, innovation investment (*x10*), consumption (*x2*), and the number of patents (*x9*); in S2, innovation investment (*x10*), foreign investment (*x6*), and the number of patents (*x9*);

in S3, consumption (*x2*), highways (*x7*), and innovation investment (*x10*); and in S4, foreign investment (*x6*), the number of patents (*x9*), and tertiary industry (*x5*).

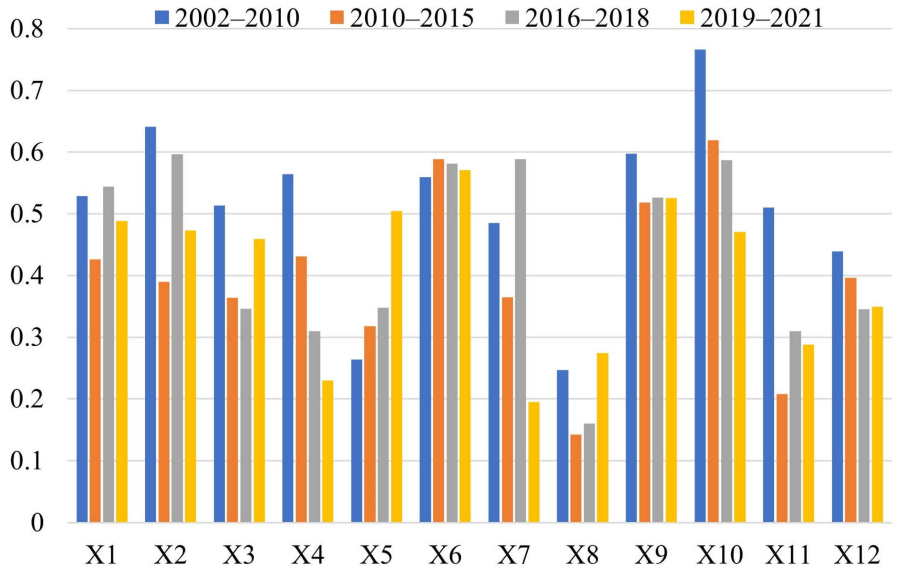

Figure 8. Factor detection results from 2002 to 2021.

Foreign investment (*x6*), the number of patents (*x9*), and innovation investment (*x10*) show strong driving forces, among which innovation investment (*x10*) is prominent in the early stages, while foreign investment (*x6*) is prominent throughout. The explanatory power of secondary industry (*x4*) and tertiary industry (*x5*) show contrasting trends, with *x4* playing a more significant role in the early stage of Henan Province's foreign trade, followed by a gradually weakening performance, and *x5* showing the exact opposite trend. In addition, the driving roles of GDP (*x1*) and consumption capacity (*x2*) are volatile, showing a stronger influence in S1 and S3 and a weaker one in the other periods.

The order of dominance of the four single-factor categories for 2002–2021 is innovation capacity, the economy, industrial structure, and transportation conditions.

3.2.2. Interaction Detection

The results of the factor interaction test (Figure 9) show that the interaction between any two factors has a more important driving force than the individual factors, indicating that influencing factors are not independent but work together.

The dominant factor interactions in S1 are tertiary industry *x5* ∩ innovation investment *x10* (0.933), innovation investment *x10* ∩ education investment *x11* (0.928), secondary industry *x4* ∩ innovation investment *x10* (0.927), GDP *x1* ∩ innovation investment *x10* (0.926), and consumption *x2* ∩ innovation investment *x10* (0.912).

The dominant factor interactions in S2 are consumption *x2* ∩ highways *x7* (0.956), foreign investment *x6* ∩ highways *x7* (0.950), GDP *x1* ∩ highways *x7* (0.928), urbanization rate *x3* ∩ highways *x7* (0.917), and consumption *x2* ∩ foreign investment *x6* (0.898).

The dominant factor interactions in S3 are highways *x7* ∩ railroads *x8* (0.955), GDP *x1* ∩ highways *x7* (0.948), secondary sector *x4* ∩ foreign investment *x6* (0.945), GDP *x1* ∩ secondary sector *x4* (0.935), and highways *x7* ∩ number of patents *x9* (0.924).

The dominant factor interactions in S4 are tertiary industry *x5* ∩ foreign investment *x6* (0.950), foreign investment *x6* ∩ innovation investment *x10* (0.919), consumption *x2* ∩ secondary industry *x4* (0.887), GDP *x1* ∩ tertiary industry *x5* (0.885), and foreign investment *x6* ∩ number of patents *x9* (0.872).

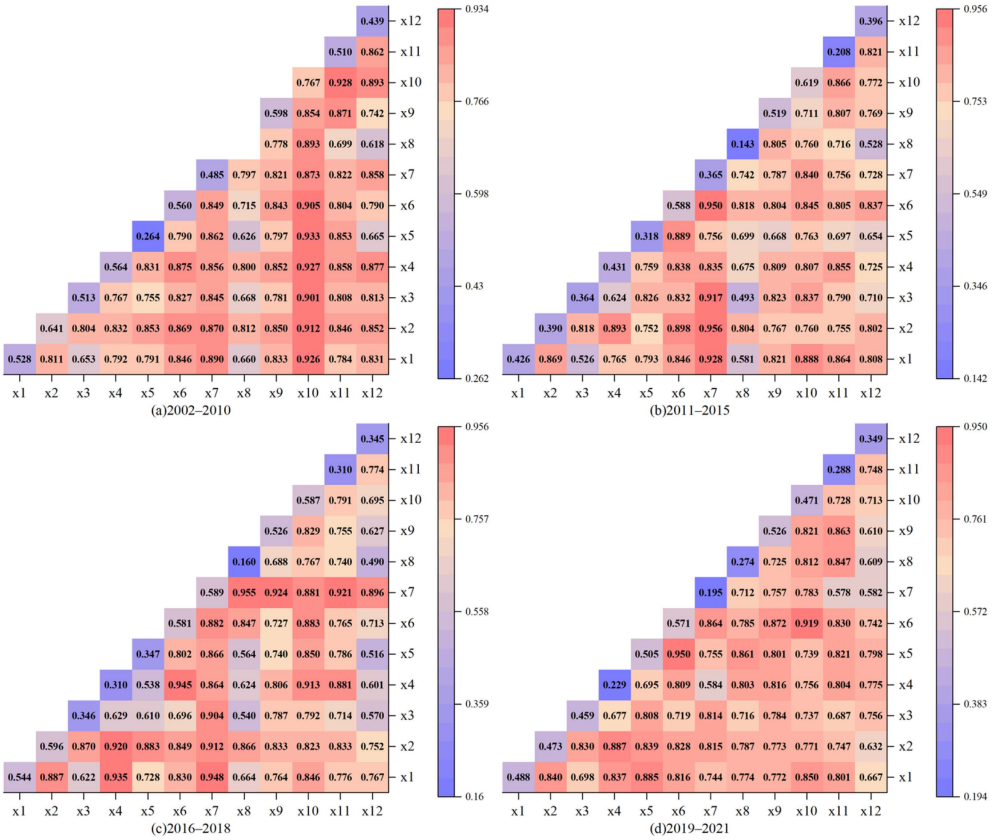

Figure 9. Factor interaction detection results from 2002 to 2021.

From the above results, the interaction effect of innovation investment (*x10*) in S1 is obviously more remarkable than that of other factors. The factors with the most apparent interaction effects in S2, S3, and S4 are highways (*x7*), consumption (*x2*), and tertiary industry (*x5*), respectively. In addition, railroads (*x8*) have little explanatory power based on the results of the single-factor test alone (2011–2018). However, the results of the interaction test show a clear explanatory role for the interaction of railroads with most of the factors.

3.3. Analysis of External Influencing Factors of Henan Province's Foreign Trade

3.3.1. Data Verification

Henan Province traded with 213 countries and regions during the study period, and due to data deficiencies, 2314 valid data were obtained after cleaning using Stata 17 software.

Sample size estimation was performed using G-Power 3.1 software before regression. Random testing and multiple linear regression modeling was conducted using the EXACT method, choosing a two-tailed test, assuming that the 12 selected variables are within the 95% confidence interval; H1 assumed that the selected variables can explain 70% of Henan's foreign trade, and H2 assumed that the explanatory power of the selected variables is not more than 50%. At this point, the number of required sample data is 133. The data of this study can fully meet this condition. Table 7 shows the statistics of the data.

In addition, the variables were tested in order to avoid disturbances caused by multicollinearity in the model. After stepwise regression using SPSS 27.0.1 software, *HPEO* and *FUEL* were excluded. Correlation analysis (Table 8) and collinearity tests (Table 9) were performed on the remaining variables. The VIF of each variable after treatment was less than 5, proving that the model does not have serious multicollinearity [61].

Table 7. Descriptive analysis.

Variable	Mean	SD	Min	p50	Max
ln*Y*	16.557	2.753	4.094	16.690	24.071
ln*DIST*	9.200	0.550	7.316	9.261	10.039
ln*HGDP*	26.559	0.774	25.013	26.852	27.540
ln*GDP*	24.567	2.024	18.953	24.377	30.780
ln*RATE*	3.256	2.789	−2.899	2.671	22.629
ln*TO*	4.046	0.496	2.427	4.039	5.839
ln*EFW*	4.107	0.153	3.384	4.109	4.496
FTA	0.134	0.341	0	0	1
ln*HPEO*	9.172	0.020	9.144	9.174	9.204
ln*PEO*	16.125	1.747	11.138	16.140	21.065
ln*ICT*	−0.770	2.364	−15.913	−0.905	3.942
ln*FUEL*	1.015	3.019	−14.951	1.647	4.593
ln*MINE*	1.046	1.772	−8.697	1.139	4.459

Table 8. Correlation coefficient matrix of each variable.

	ln*DIST*	ln*HGDP*	ln*GDP*	ln*RATE*	ln*TO*	ln*EFW*	*FTA*	ln*PEO*	ln*ICT*	ln*MMTL*
ln*DIST*	1									
ln*HGDP*	0.013	1								
ln*GDP*	−0.036	0.098	1							
ln*RATE*	0.044	0.063	−0.127	1						
ln*TO*	−0.156	−0.025	−0.205	−0.202	1					
ln*EFW*	0.097	0.042	0.325	−0.328	0.150	1				
FTA	−0.211	0.133	0.234	0.177	0.112	0.117	1			
ln*PEO*	−0.067	−0.012	0.729	0.251	−0.379	−0.151	0.235	1		
ln*ICT*	0.088	−0.059	0.369	−0.163	0.215	0.443	0.229	0.142	1	
ln*MMTL*	−0.030	0.072	0.089	0.029	−0.091	0.112	−0.006	0.124	0.107	1

Table 9. Collinearity statistics.

Variable	Tolerance	VIF
ln*DIST*	0.870	1.150
ln*HGDP*	0.903	1.108
ln*GDP*	0.217	4.599
ln*RATE*	0.674	1.484
ln*TO*	0.715	1.398
ln*EFW*	0.492	2.035
FTA	0.767	1.304
ln*PEO*	0.215	4.650
ln*ICT*	0.649	1.541
ln*MMTL*	0.927	1.078

Based on the basic gravity model, the indicators of economic freedom, FTAs, and population were added (Table 9), and the total amount of import and export between Henan Province and the trading countries was substituted into the model as the dependent variable, which was analyzed with Stata software. Post hoc tests were performed after obtaining the regression results. Using G-Power 3.1 software (*t*-test post hoc for linear multiple regression, fixed model), the effect size was 0.772. For a two-tailed test with a sample size of 2314, the result was 1, which reaches the permissible value [62,63].

As for Henan's foreign trade development data, the analysis of internal influencing factors was divided into four stages. In order to verify the scientific validity of this division in the analysis of the gravity model, a Chow test was conducted. The results show that there were structural changes before and after 2010. Considering the sample size and the

results of the Chow test (Table 10), 2010 was taken as the time point in analyzing external factors, and S2–S4 (2011–2021) were analyzed together.

Table 10. Results of Chow test.

Year	F-Statistic	*p*-Value	Likelihood Ratio	*p*-Value	Whether the Structure Changed
2010	2.6911	0.0019	29.6948	0.0010	YES
2015	1.5200	0.1173	16.8192	0.0785	NO
2018	0.8328	0.6071	9.2302	0.5104	NO

In the analysis of external factors by period, the same methodology was used as in the analysis of the overall data: a collinearity test (Table 11) was performed first, and stepwise regression eliminated some of the factors and analyzed them. All remaining variables passed the significance test. In 2002–2010, *HPEO* and *FUEL* were excluded; in 2011–2021, *HPEO*, *FUEL*, *EFW*, and *ICT* were excluded.

Table 11. Collinearity statistics for various periods.

Variable	VIF		
	2002–2021	2002–2010	2011–2021
ln*DIST*	1.150	1.142	1.114
ln*HGDP*	1.108	1.072	1.016
ln*GDP*	4.599	3.791	3.512
ln*RATE*	1.484	1.398	1.571
ln*TO*	1.398	1.668	1.237
FTA	1.304	1.460	1.210
ln*PEO*	4.650	4.123	3.871
ln*MMTL*	1.078	1.069	1.036
ln*ICT*	1.541	1.627	
ln*EFW*	2.035	1.918	

3.3.2. Results of the Trade Gravity Model

Regression results (Table 12) show that S1 has the most variables passing the significance level test, which is the same as in 2002–2021; distance, GDP, FTAs, exchange rate of trade country, trade openness, and population all pass the significance test. S2–S4 have the best fitting results. R^2 is significantly higher than that of the other periods.

(1) The weakening effect of distance is most evident in S1. With the development of the China–Europe liner (via Henan) and international shipping (Zhengzhou airport) in 2013, the hindering effect of distance was diminished. However, overall, the disadvantages of Henan's geographic location still exist.

(2) In terms of economic level, domestic and foreign GDP plays a significant role in promoting Henan's foreign trade. It steadily promotes Henan's import and export trade, with slight fluctuations between 0.607 and 0.929 at all stages. Henan's GDP mainly plays a driving role in S1: assuming all other conditions remain unchanged, every 1% increase in Henan's GDP in this period brings about a 0.844% increase in import and export volume. In contrast, the GDP of the trading countries mainly affects S2–S4.

(3) Regarding openness, trade openness and FTAs show significant promotion effects. The most influential is the degree of trade openness, followed by FTAs. Observed by period, economic freedom only shows a significant promotion effect in the S1, but the performance of economic freedom is not bad in the whole study period.

(4) In terms of population size, the population size of trading countries consistently promotes the development of foreign trade in Henan Province with a similar driving force over many years.

(5) Regarding export structure, the export of ICT products passes the significance test only in S1 and has a negative effect. Ore and metal exports show a facilitating effect in all periods, with the most potent effect in S1.

Table 12. Regression analysis results of the trade gravity model.

Variable	lnTotal Trade		
	2002–2021	2002–2010 (S1)	2011–2021 (S2–S4)
ln*DIST*	−0.239 ***	−0.373 ***	−0.162 ***
	(0.053)	(0.093)	(0.060)
ln*HGDP*	0.807 ***	0.844 ***	0.607 ***
	(0.037)	(0.097)	(0.134)
ln*GDP*	0.836 ***	0.777 ***	0.929 ***
	(0.029)	(0.049)	(0.028)
ln*RATE*	0.048 ***	0.038 *	0.059 ***
	(0.012)	(0.021)	(0.014)
ln*TO*	0.748 ***	0.703 ***	0.724 ***
	(0.065)	(0.123)	(0.070)
FTA	0.514 ***	0.712 ***	0.459 ***
	(0.092)	(0.205)	(0.091)
ln*PEO*	0.408 ***	0.402 ***	0.337 ***
	(0.034)	(0.060)	(0.033)
ln*MMTL*	0.094 ***	0.102 ***	0.099 ***
	(0.016)	(0.027)	(0.018)
ln*EFW*	1.035 ***	1.617 ***	
	(0.255)	(0.434)	
ln*ICT*	−0.044 ***	−0.083 ***	
	(0.014)	(0.026)	
Constant	−37.425 ***	−37.832 ***	−29.511 ***
	(1.568)	(3.319)	(3.748)
Number of obs	2314.000	1008.000	1306.000
R^2	0.772	0.651	0.834

Note: *** is the level of significance ($p < 0.01$) and * is the level of significance ($p < 0.1$).

In summary, most factors, except for geographical distance, positively contribute to foreign trade, with the GDP of the trading countries having a significant impact.

4. Discussion

4.1. Internal Influences on Trade Patterns in Henan Province

The results of geodetector calculations show that economic development and innovation capacity are the dominant factors contributing to the unbalanced development of foreign trade in the cities of Henan Province.

For different development periods of Henan Province as a whole, innovation input provides the driving force for the development of the region's foreign trade, which determines the starting height of its development. Then, with the development of the scale of foreign trade, the transportation capacity of highways provides an essential guarantee of the region's long-term development. After entering a period of steady growth, consumption represents the region's economic development level, and a high level of consumption is conducive to foreign trade. Finally, the development of tertiary industry shows that demand, supply, industry, and division of labor in the region are refined, and tertiary industry can promote the development and improvement of the market system and create favorable conditions for foreign trade.

Innovativeness is notable in Henan Province (factor *x10*), but the commodity structure shows that the high-tech aspect's core content is yet to be formed. Therefore, Henan Province should vigorously develop high-tech industries and emphasize cultivating and importing talents so that innovation inputs can play a more significant role.

The strong interaction effect of the highway and railroad factors suggests that they play an indispensable role in the development of Henan's foreign trade, which is consistent with the current situation of Henan's land transportation: although as an inland province, it has a natural geographic disadvantage in terms of foreign trade, it has a comprehensive transportation network with a mileage of 280,000 km. Several cities in Henan are national transportation hubs, and Zhengzhou, the provincial capital, is a comprehensive international transportation center. Therefore, transportation factors should continue to play a critical role in Henan Province's foreign trade.

In addition to the above quantitative analysis results, some qualitative factors, such as policy factors, should be considered. Policy conditions, for example, the "One Belt, One Road China-EU Liner" and the "Zhengzhou-Luxembourg Air Silk Road", should also be fully utilized by Henan Province to promote its industrial transformation and economic development, which will promote the development of foreign trade. Zhengzhou and Luxembourg's "Air Silk Road" cargo trade covers over 200 cities in 24 European countries. Over the past ten years, the cargo volume of Luxembourg Cargo Airlines in Zhengzhou Airport has reached 1 million tons. The China–Europe liner (Zhongyu) covers a network of more than 40 countries and 140 cities in Europe, ASEAN, and Asia–Pacific. By the end of August 2023, the total cumulative cargo value of the China–Europe liner (Zhongyu) was about CNY 235 billion, and the cargo weight was about 5.9 million tons.

Moreover, supported by Henan government policies, the province's cross-border e-commerce has more than 46,000 enterprises on record, 206 overseas warehouses in 47 countries and regions, and trade covering more than 200 countries and regions. The province's cross-border e-commerce import and export volume rose from less than CNY 100 million in 2014 to CNY 221 billion in 2022. In terms of culture, the province concluded 125 sister city agreements with 51 countries. The government of Henan has built seven centers in Zambia, Ethiopia, Eritrea, and other countries, including the Chinese Traditional Medicine Center, China Trauma Treatment Center, and China Maternal and Child Health Center, which have treated more than 7 million people in the recipient countries. "Shaolin Kungfu", "Taiji Culture" and other cultural and tourist features have also greatly enhanced the advantages of our province's open channels. Policies have greatly influenced, all in all, the development of foreign trade in Henan Province.

4.2. External Influences on Trade Patterns in Henan Province

Gravity modeling calculations show that most factors play a positive role.

One of the strong negative effects is geographical distance [64]. However, with the continuous development of transportation, the negative effect of the distance factor on foreign trade is gradually reduced. With Henan's transportation advantages, further promotion should be made to strengthen ties with the rest of the world through good transportation [65]. In addition, ICT also shows a weaker negative impact. Henan Province has processed and exported a large number of ICT products and competes with countries that are high exporters of ICT products, which is not favorable in terms of trade.

The factors that play a positive role in the long run are foreign and domestic GDP, the exchange rate of the target trade country, FTAs, trade openness, and population. Among them, the target trade countries' exchange rates do not play a significant role.

It is generally believed that the higher the level of GDP in Henan Province, the more it attracts foreign investors to trade with it. The GDP of the target country, on the other hand, reflects the economic level of the target country (high-economic-level countries are more willing to conduct foreign trade), which is consistent with the data in Section 3.3.2, and the strength of the role of the GDP of the target country is the most prominent in S2–S4. Therefore, the development of the regional economy should be the focus of Henan, driving

the development of foreign trade and then forming a positive cycle of foreign trade to feed the regional economy pattern.

Trade barriers between Henan Province and trading countries can be eliminated by signing FTAs, so foreign trade can be significantly facilitated by establishing FTAs [66]. Furthermore, the calculation results show that these advantages are fully utilized by Henan Province to develop in-depth cooperation with FTA partner countries. In addition, the role of FTAs is relatively weakened during periods of high trade openness, with high openness in trading countries outweighing FTA capacity. Therefore, Henan Province should actively rely on national policies and carry out foreign trade activities in a targeted manner.

5. Conclusions

The research above shows the following:

(1) The overall size of Henan Province's foreign trade grew, rising from USD 3.7 billion to USD 127 billion. The trade pattern, on the other hand, shows more obvious spatial and temporal heterogeneity, which can be divided into a starting period (2002–2010), a rapid development period (2011–2015), a period of stable growth (2016–2018), and a period of restored growth (2019–2021). In addition, significant spatial heterogeneity exists in the distribution of foreign trade within Henan.

(2) The overall commodity structure is relatively homogeneous, the competitive advantage is not strong, and the dependence on trade with the United States is enormous.

(3) In terms of internal influencing factors, the innovation factor (*x10*) and transportation factor (*x7*, *x8*) dominate.

(4) Regarding external influencing factors, most factors, except distance, play a positive role, while the negativity of distance is gradually offset by the progress of science and technology. Among the positive factors, foreign and domestic GDP, FTA, trade openness, and population are the main long-lasting factors with significant influence.

(5) Relevant policies should be implemented by Henan Province so it can continue to make efforts in innovation and transportation and carry out foreign trade activities in a targeted manner to form a positive cycle driven by a "regional economy-foreign trade scale."

In addition, this study has a few limitations. Firstly, the types of research methods used can be deepened. The interpretation of some data needs to be revised, such as the interpretation of Henan Province as a large population province. However, its population factors have not passed the significance test, and their role still needs to be clarified. Secondly, the impact of major political and economic events on the pattern of foreign trade is yet to be fully interpreted and analyzed. In the next step of the research program, the research methodology will be deepened to provide a better interpretation of the data, increase the analysis of significant events, increase the in-depth study of countries that trade closely with Henan Province, and try to obtain the reasons for the formation of such stable foreign trade patterns in order to make better suggestions for the development of foreign trade in Henan Province.

Author Contributions: Conceptualization, methodology and software, Y.W. (Yalin Wang); validation, formal analysis and investigation, Y.W. (Yabo Wang) and S.Z.; resources and data curation, Y.W. (Yalin Wang) and J.Z.; writing—original draft preparation, writing—review and editing, Y.W. (Yalin Wang), J.L. and X.Z.; visualization, Y.W. (Yabo Wang); supervision, project administration and funding acquisition, J.L. and Y.Z. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Social Science Fund of China—"Theory and Method of Geo-Environmental Analysis in the Era of Big Data", grant number 20&ZD138.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: We thank all the participants involved in the project for their contribution to our research. At the same time, we thank the editors and reviewers for their valuable comments.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Classification and detailed description of China's import and export products.

Commodity	Details
T1	Live animals; animal products.
T2	Plant products.
T3	Animal and vegetable oils and fats and their decomposition products; refined edible fats and oils; animal and vegetable waxes.
T4	Food; beverages, wine, and vinegar; tobacco and tobacco substitute products.
T5	Minerals.
T6	Products for the chemical industry and its related industries.
T7	Plastics and their products; rubber and its products.
T8	Rawhide, leather, fur, and their products; saddles and drawstrings; travel goods, handbags, and similar containers; animal intestinal thread (except silk) products.
T9	Wood and wood products; charcoal; cork and cork products; straws, needle fescues, or other knitting material products; baskets and wicker knitted products.
T10	Wood pulp and other fibrous cellulose pulps; recycled (waste shredded) paper or cardboard; paper, cardboard, and their products.
T11	Textile raw materials and textile products.
T12	Shoes, hats, umbrellas, staffs, whips, and their parts; processed feathers and their products; artificial flowers; human hair products.
T13	Products of stone, gypsum, cement, asbestos, mica, and similar materials; ceramic products; glass and its products.
T14	Natural or cultured pearls, precious or semi-precious stones, precious metals, clad precious metals, and their products; imitation jewelry, coins.
T15	Base metals and their products.
T16	Machines, mechanical appliances, electrical equipment, and parts thereof; tape recorders and sound players; television images, sound recording and playback gear, and their parts and accessories.
T17	Vehicles, aircraft, ships, and related transport equipment.
T18	Optical, photographic, film, measurement, inspection, medical, or surgical instruments and equipment; precision instruments and equipment; clocks and watches; musical instruments; parts of the above items, accessories.
T19	Weapons and ammunition and their parts and accessories.
T20	Miscellaneous products.
T21	Artwork.
T22	Special trading items and unclassified goods.

References

1. Lin, Y.; Li, Y. Exports and China's Economic Growth: A Demand-Oriented Analysis. *J. China Econ. Q.* **2003**, *3*, 779–794.
2. Lavallée, E.; Lochard, J. International Trade and Face-to-Face Diplomacy. *Rev. World Econ.* **2022**, *158*, 987–1010. [CrossRef]
3. Lourenço, L.d.S.; Vasconcelos, C.R.F. Impacts of Exchange Rate Non-Linearity on Brazilian Foreign Trade. *Int. Econ. Econ. Policy* **2019**, *16*, 679–699. [CrossRef]
4. Gürtler, M. Dynamic Analysis of Trade Balance Behavior in a Small Open Economy: The J-Curve Phenomenon and the Czech Economy. *Empir. Econ.* **2019**, *56*, 469–497. [CrossRef]
5. Harding, T.; Venables, A.J. The Implications of Natural Resource Exports for Nonresource Trade. *IMF Econ. Rev.* **2016**, *64*, 268–302. [CrossRef]

6. Kalai, M.; Zghidi, N. Foreign Direct Investment, Trade, and Economic Growth in MENA Countries: Empirical Analysis Using ARDL Bounds Testing Approach. *J. Knowl. Econ.* **2019**, *10*, 397–421. [CrossRef]
7. Movchan, V.; Rutherford, T.F.; Tarr, D.G.; Yonezawa, H. The Importance of Deep Integration in Preferential Trade Agreements: The Case of a Successfully Implemented Ukraine–Turkey Free Trade Agreement. *Rev. World Econ.* **2023**, *159*, 1–50. [CrossRef]
8. Luo, H.; Qu, X. Export Trade, Absorptive Capacity, and High-Quality Economic Development in China. *Systems* **2023**, *11*, 54. [CrossRef]
9. Xiao, H.; Cheng, J.; Wang, X. Does the Belt and Road Initiative Promote Sustainable Development? Evidence from Countries along the Belt and Road. *Sustainability* **2018**, *10*, 4370. [CrossRef]
10. Menhas, R.; Mahmood, S.; Tanchangya, P.; Safdar, M.N.; Hussain, S. Sustainable Development under Belt and Road Initiative: A Case Study of China-Pakistan Economic Corridor's Socio-Economic Impact on Pakistan. *Sustainability* **2019**, *11*, 6143. [CrossRef]
11. Ruan, W.-X.; Yu, X.; Wang, S.-Y.; Zhao, T.-C.; Liu, Y.-Z. Exploration of China–ASEAN Trade Relations in the Context of Sustainable Economic Development—Based on the Lotka–Volterra Model. *Sustainability* **2023**, *15*, 517. [CrossRef]
12. Du, B.; Gao, P.; Song, C.; Wang, Y. Evolution of export trade in Qinghai and influencing factors. *J. Beijing Norm. Univ. Nat. Sci.* **2022**, *58*, 161–167. [CrossRef]
13. Du, Y.; Zong, H. The evolution and influencing factors of spatial pattern of trade between Chongqing and ASEAN countries under the background of "The Belt and Road Initiative". *J. World Reg. Stud.* **2020**, *29*, 697–707. [CrossRef]
14. Cheng, Y.; Liu, H.; Song, T. Spatio-temperal pattern and driving factors of foreign economic development in Southwest China. *J. World Reg. Stud.* **2018**, *27*, 77–89. [CrossRef]
15. Jiang, X.; Yang, Y.; Wang, S. Analysis of export trade's spatial pattern evolution and influencing factors of Gansu Province with "the Belt and Road" areas. *J. World Reg. Stud.* **2020**, *29*, 1029–1039. [CrossRef]
16. Liang, Y.; Liu, L.; Chen, W. Spatial and Temporal Changes in the Pattern of Export Trade between Guangdong Province and the Countries along "One Belt and One Road". *J. Trop. Geogr.* **2015**, *35*, 664–670. [CrossRef]
17. Song, Z.; Tao, L.; Liu, W. Trade pattern change of Hainan Province and its economic connection with provinces in China's mainland. *J. Resour. Sci.* **2021**, *43*, 256–268. [CrossRef]
18. Wang, Y.; Zhang, Z.; Chen, Y. The Temporal and Spatial Evolution of Jiangsu's Import and Export Trade under the "One Belt and One Road" and Analysis of the Influencing Factors. *J. Shanxi Norm. Univ. Nat. Sci. Ed.* **2020**, *34*, 112–118. [CrossRef]
19. Xu, J.; Song, Z. The geo-economic relations between Hainan Free Trade Port and Pan-South China Sea countries and its impact factors. *J. World Reg. Stud.* **2022**, *31*, 737–747. [CrossRef]
20. Zeng, F. Status of Shanghai Foreign Trade in Global Value Chains and Promotion Strategies. *J. Shanghai Univ. Int. Bus. Econ.* **2018**, *25*, 37–48. [CrossRef]
21. Li, X.; Zheng, S.; Liang, Y. Integration Process of the Guangdong-Hongkong-Macao Greater Bay Area under the Promotion of Trade. *J. Trop. Geogr.* **2017**, *37*, 792–801. [CrossRef]
22. Su, M. The Impact of Guangdong's Foreign Trade on Port Logistics Development and Countermeasures under the "Maritime Silk Road" Initiative. *J. Pract. Foreign Econ. Relat. Trade* **2020**, *9*, 93–96. [CrossRef]
23. Wang, H.; Sheng, X.; Zhao, L. Measurement and comparison of foreign trade competitiveness in the Yangtze River Economic Belt. *J. Econ. Theory Bus. Manag.* **2021**, *41*, 96–112.
24. Zheng, L.; Song, Z.; Liu, W.; Liu, Y. Spatial pattern and trade structure of foreign trade in western China. *J. Geogr. Res.* **2015**, *34*, 1933–1942.
25. Liu, Z.; Zhang, W.; Liu, W. Spatial Pattern of Foreign Trade in Northeast China. *J. Sci. Geogr. Sin.* **2016**, *36*, 1349–1358. [CrossRef]
26. Zhao, D.; Jia, X. Study on the new pattern of trade development between Northeast China and the countries along the "Belt and Road". *J. Commer. Res.* **2018**, *60*, 62–70. [CrossRef]
27. Liu, Y.; Yuan, J. Spatiotemporal evolution of the trade pattern of the three northeastern provinces and the countries along the "Belt and Road". *J. Prices Mon.* **2020**, *4*, 28–36. [CrossRef]
28. Li, J.; Yang, X.; Wu, H.; Yang, Y. Geo-economic Relations and Foreign Trade Effects between Southwest China and Southeast Asian Countries. *J. Areal Res. Dev.* **2021**, *40*, 13–19. [CrossRef]
29. Li, N.; Sun, L.; Luo, X.; Kang, R.; Jia, M. Foreign Trade Structure, Opening Degree and Economic Growth in Western China. *Economies* **2019**, *7*, 56. [CrossRef]
30. Gao, K.; Yang, Y. An Analysis on the Trade Pattern of Jiangxi Province and Countries along "the Belt and Road Initiative". *J. East. China Econ. Manag.* **2018**, *32*, 26–31. [CrossRef]
31. Song, Z.; Che, Z.; Liu, W. Analysis of spatial pattern and trade structure of foreign trade in Central China. *J. Geogr. Res.* **2017**, *36*, 2291–2304.
32. Xiong, R.; Luo, C. Empirical Analysis of the Impact of Environmental Regulation on Export Trade in Hubei Province. *J. Commer. Econ.* **2022**, *5*, 174–177.
33. Ren, Z.; Li, J. Opportunities and Challenges for Henan Province under the "Belt and Road". *J. CO-Oper. Econ. Sci.* **2017**, *24*, 54–55. [CrossRef]
34. Wang, W.; Guo, P.; Fang, Q. Analysis of Export Trade Characteristics and Problems in Henan Province. *J. North. Econ. Trade* **2018**, *5*, 11–12.
35. Guo, J. Research on the Policy Support of the Construction of "Air Silk Road" in Henan. *J. Foreign Econ. Relat. Trade* **2019**, *1*, 79–81+89.
36. Yi, H. Research on Challenges and Strategies of High Quality Development of Henan Foreign Trade under the Perspective of Sustainability. *J. Qual. Mark.* **2020**, *15*, 33–35+39.

37. Zhang, X. Study on the Path of Building a Comprehensive Pilot Area of the "Air Silk Road" in the Inland Areas. *J. Reg. Econ. Rev.* **2021**, *1*, 155–160. [CrossRef]
38. Liu, Z. Gray correlation analysis of Henan's economic growth and openness to the outside world. *J. China Mark.* **2017**, *11*, 127. [CrossRef]
39. Xie, J. Analysis of the Current Situation of Foreign Trade Dependence in Central China-Taking Henan Province as an Example. *J. Farm. Mach.* **2018**, *7*, 70–73. [CrossRef]
40. Feng, M.; Wei, X.; Zhao, R. Analysis of trade integration and complementarity between Henan and Latin America. *J. Manag. Eng.* **2020**, *4*, 15–24. [CrossRef]
41. Cui, L.; Cao, L.; Liu, Q. Study on Henan's Promotion of High-Level Opening to the World under the New Development Pattern. *J. Stat. Theory Pract.* **2022**, *4*, 50–56.
42. Zhou, L.; Zhen, F.; Wang, Y.; Xiong, L. Modeling the Spatial Formation Mechanism of Poverty-Stricken Counties in China by Using Geographical Detector. *Sustainability* **2019**, *11*, 4752. [CrossRef]
43. Song, T.; Cheng, Y.; Liu, W.; Liu, H. Spatial Difference and Mechanisms of Influence of Geo-Economy in the Border Areas of China. *J. Geogr. Sci.* **2017**, *27*, 1463–1480. [CrossRef]
44. He, Q.; Yan, M.; Zheng, L.; Wang, B. Spatial Stratified Heterogeneity and Driving Mechanism of Urban Development Level in China under Different Urban Growth Patterns with Optimal Parameter-Based Geographic Detector Model Mining. *Comput. Environ. Urban Syst.* **2023**, *105*, 102023. [CrossRef]
45. Polykretis, C.; Alexakis, D.D. Spatial Stratified Heterogeneity of Fertility and Its Association with Socio-Economic Determinants Using Geographical Detector: The Case Study of Crete Island, Greece. *Appl. Geogr.* **2021**, *127*, 102384. [CrossRef]
46. Xu, J.; Zhao, J.; Zhang, H.; Guo, X. Evolution of the Process of Urban Spatial and Temporal Patterns and Its Influencing Factors in Northeast China. *J. Urban Plan. Dev.* **2020**, *146*, 05020017. [CrossRef]
47. Qian, X.; Wang, D.; Nie, R. Assessing Urbanization Efficiency and Its Influencing Factors in China Based on Super-SBM and Geographical Detector Models. *Environ. Sci. Pollut. Res.* **2021**, *28*, 31312–31326. [CrossRef]
48. Cheng, H.; Wang, J.; Hu, M. Study on the Spatial Evolution of China's Pulp and Paper Product Import Trade and Its Influencing Factors. *Forests* **2023**, *14*, 674. [CrossRef]
49. Musa, A.M.; Wasonga, O.V.; Mtimet, N. Factors Influencing Livestock Export in Somaliland's Terminal Markets. *Pastoralism* **2020**, *10*, 1. [CrossRef]
50. Arana-Nicanor, R.A.; Llacuachaqui-Tovar, V.H.; Vicente-Ramos, W.E. Internal Factors That Determine the Success of Peruvian Exports of Ginger to The United States in the Period 2006–2020. *AL* **2021**, *8*, 415–421. [CrossRef]
51. Aksenov, G.; Li, R.; Abbas, Q.; Fambo, H.; Popkov, S.; Ponkratov, V.; Kosov, M.; Elyakova, I.; Vasiljeva, M. Development of Trade and Financial-Economical Relationships between China and Russia: A Study Based on the Trade Gravity Model. *Sustainability* **2023**, *15*, 6099. [CrossRef]
52. William, A.B. The international gold standard reinterpreted, 1914–1934. *J. Natl. Bur. Econ. Res.* **1940**, *32*, 77–102.
53. Balassa, B. Trade Liberalisation and "Revealed" Comparative Advantage. *Manch. Sch.* **1965**, *33*, 99–123. [CrossRef]
54. Yang, W.; Xue, F.; Shi, J.; Shao, Y.; Wang, D. Factors Affecting the Trade Dependence Relationship of Asian Countries with China: Implications for China's Belt and Road Initiative. *Sustainability* **2021**, *13*, 10844. [CrossRef]
55. Bhowmik, R.; Zhu, Y.; Gao, K. An Analysis of Trade Cooperation: Central Region in China and ASEAN. *PLoS ONE* **2021**, *16*, e0261270. [CrossRef] [PubMed]
56. Brown, A.J. *Applied Economics: Aspects of the World Economy in War and Peace*; George Allen & Urwin: London, UK, 1947.
57. Wang, J.; Xu, C. Geodetector: Principle and prospective. *J. Acta Geogr. Sin.* **2017**, *72*, 116–134. [CrossRef]
58. Han, Y.; Zhang, Y. Spatiotemporal Variations of County Economies and Influencing Factors: A Case Study of Gansu Province. *J. Geo-Inf. Sci.* **2019**, *21*, 1735–1744. [CrossRef]
59. Ye, C.; Hu, M.; Lu, L.; Dong, Q.; Gu, M. Spatio-Temporal Evolution and Factor Explanatory Power Analysis of Urban Resilience in the Yangtze River Economic Belt. *Geogr. Sustain.* **2022**, *3*, 299–311. [CrossRef]
60. Linnemann, H. *An Econometric Study of International Trade Flows*; North Holland Publishing: Amsterdam, The Netherlands, 1966.
61. Chen, Q. *Advanced Econometrics and Stata Applications M*; Higher Education Press: Beijing, China, 2014; p. 111.
62. Cohen, J. Things I Learned (so Far). *Am. Psychol.* **1990**, *45*, 1304–1312. [CrossRef]
63. Cohen, J. Set Correlation and Contingency Tables. *J. Appl. Psychol. Meas.* **1988**, *12*, 425–434. [CrossRef]
64. He, Q.; Cao, X. Pattern and Influencing Factors of Foreign Direct Investment Networks between Countries along the "Belt and Road" Regions. *Sustainability* **2019**, *11*, 4724. [CrossRef]
65. Choi, K.-S. The Current Status and Challenges of China Railway Express (CRE) as a Key Sustainability Policy Component of the Belt and Road Initiative. *Sustainability* **2021**, *13*, 5017. [CrossRef]
66. Khati, P.; Kim, C. Impact of India's Free Trade Agreement with ASEAN on Its Goods Exports: A Gravity Model Analysis. *Economies* **2023**, *11*, 8. [CrossRef]